REMARKS

Claims 1-31, 52, and 54-59 are pending in the application with claims 1, 3, 20, 52, and 55 amended herein. Applicant expresses appreciation for the allowance of claims 56, 57, and 59 and for the indication that claims 10-12 and 28 set forth allowable subject matter. Applicant notes that claim 26 is listed as rejected in the Office Action Summary. However, no rejection of claim 26 is indicated in the text of the Office Action. Applicant requests clarification.

Claims 1, 2, 6-8, 13-15, 18-20, 24, 25, 29-31, 52, 54, and 55 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Ota. Applicant requests reconsideration.

Amended claim 1 sets forth a dielectric layer forming method that includes, among other features, providing a substrate with a silicon-containing surface, forming a first metal-containing dielectric layer consisting of metal oxide over the surface, and forming a second metal-containing dielectric layer consisting of metal oxide on and in contact with the first metal-containing dielectric layer. All of the metal of the first dielectric layer consists of at least one element selected from Group IVB of the Periodic Table. All of the metal of the second dielectric layer consists of at least one element selected from Group IIIB of the Periodic Table. Pages 2-3 of the Office Action allege that Ota discloses every element of claim 1. However, Applicant asserts that Ota does not disclose or suggest forming a second metal-containing dielectric layer consisting of metal oxide on and in contact with a first metal-containing dielectric layer consisting of metal oxide.

Pages 2-3 of the Office Action allege that $HfSiO_2$ film 21 of Ota discloses the claimed first metal-containing dielectric layer and that HfO_2 film 22 discloses the claimed second metal-containing dielectric layer since paragraph [0077] states that the film material can include La. However, amended claim 1 sets forth that the first metal-containing dielectric layer consists of metal oxide. Pursuant to MPEP 2111.03 "the transitional phrase 'consisting of' excludes any element, step, or ingredient not specified in the claim." Accordingly, $HfSiO_2$ film 21 does not disclose a dielectric layer consisting of metal oxide. Because the claim 1 dielectric layer "consists" of metal oxide, the claim expressly sets forth that silicon, a non-metal is excluded. At least for such reason, $HfSiO_2$ film 21 does not disclose the claimed first metal-containing dielectric layer.

Applicant further asserts that $HfSiO_2$ film 21 does not suggest the claimed first metal-containing dielectric layer consisting of metal oxide. No person of ordinary skill would be motivated to substitute the $HfSiO_2$ film 21 of Ota with a dielectric layer consisting of metal oxide. Such a substitution would render the Ota device inoperable for its intended purpose. Paragraph [0077] of Ota states that a 3-layer structure of silicate/oxide/silicate is used. Paragraphs [0061] to [0064] along with [0099] to [0103] describe that the purpose of using $HfSiO_2$ instead of HfO_2 is to provide a dielectric layer that is less reactive with the Si substrate and to prevent formation of a lower dielectric constant oxide layer at the interface between the dielectric layer and the silicon substrate. For example, at least paragraph [0100] expressly teaches that HfO_2 should <u>not</u> be used in place of $HfSiO_2$. If HfO_2 is substituted for $HfSiO_2$, then the express teaching of Ota is that the intended purpose of $HfSiO_2$ film 21 will be frustrated.

A prior art reference must be considered in its entirety, i.e., as a whole, including portions that would lead away from the claimed invention. MPEP § 2141.02 citing W.L. Gore & Associates, Inc. v. Garlock, Inc., 721 F.2d 1540, 220 USPQ 303 (Fed. Cir. 1983), cert. denied, 469 U.S. 851 (1984). Accordingly, the Office is required to consider the teachings of Ota paragraphs [0061] to [0064] and [0099] to [0103] that HfO_2 should not be substituted in place of $HfSiO_2$. It is clear from the express teachings of Ota that Ota considered the similar dielectric constants of HfO_2 and $HfSiO_2$ and rejected HfO_2 as not being suitable for use in the Ota devices as a result of other considerations more weighty in the context of Ota. Accordingly, no suggestion or motivation can be considered to exist to modify $HfSiO_2$ film 21 of Ota to instead consist of metal oxide, as set forth in claim 1. At least for such reason, Ota fails to disclose or suggest every claim limitation and claim 1 is patentable over Ota. Claims 2, 6-8, 13-15, 18, and 19 depend from claim 1 and are patentable at least for such reason as well as for the additional limitations of such claim not disclosed.

Amended claim 20 sets forth a MOS transistor forming method that includes, among other features, providing a semiconductor substrate having a surface comprising silicon, forming a hafnium-containing dielectric layer consisting of hafnium oxide on and in contact with the surface, forming a lanthanum-containing dielectric layer on and in contact with the hafnium-containing dielectric layer, and forming a gate electrode over the hafnium-containing and lanthanum-containing dielectric layers. Forming the hafnium-containing dielectric layer includes initially forming a hafnium-containing metal

layer. Forming the lanthanum-containing dielectric layer includes initially forming a lanthanum-containing metal layer.

Page 4 of the Office Action alleges that Ota discloses every limitation of claim 20. However, Applicant asserts that Ota does not disclose or suggest a hafnium-containing dielectric layer consisting of hafnium oxide formed on and in contact with a silicon-comprising surface of a semiconductor substrate. Such failure of Ota to disclose the subject matter of amended claim 20 may be appreciated from the discussion above regarding the deficiencies of Ota as applied to claim 1. At least for such reason, claim 20 is patentable. Claims 24, 25, and 29-31 depend from claim 20 and are patentable at least for such reason as well as for the additional limitations of such claims not disclosed or suggested.

Amended claim 52 sets forth a dielectric layer forming method that includes, among other features, providing a substrate with a silicon-containing surface, forming a first metal-containing dielectric layer over the surface, and forming a second metal-containing dielectric layer on and in contact with the first metal-containing dielectric layer. The first dielectric layer consists essentially of hafnium oxide. The second dielectric layer consists essentially of lanthanum oxide. As may be appreciated from the discussion above regarding the deficiencies of Ota as applied to claims 1 and 20, Ota does not disclose or suggest a dielectric layer consisting essentially of lanthanum oxide on and in contact with a dielectric layer consisting essentially of hafnium oxide. At least for such reason, claim 52 is patentable.

Claim 54 sets forth a MOS transistor forming method that includes, among other features, providing a semiconductor substrate having a surface comprising silicon, forming a dielectric layer consisting of hafnium oxide, forming a dielectric layer consisting of lanthanum oxide on and in contact with the hafnium oxide dielectric layer, and forming a gate electrode over the hafnium oxide and lanthanum oxide dielectric layers. As may be appreciated from the discussions above regarding the deficiencies of Ota as applied to claims 1 and 20, Ota does not disclose or suggest the claimed lanthanum oxide dielectric layer on and in contact with a hafnium oxide dielectric layer. At least for such reason, claim 54 is patentable.

Amended claim 55 sets forth a MOS transistor method that includes, among other features, providing a semiconductor substrate having a surface containing silicon, forming a layer consisting of hafnium on and in contact with the surface, oxidizing the hafnium layer into a dielectric layer consisting of hafnium oxide, forming a lanthanum-containing dielectric layer on and in contact with the hafnium oxide dielectric layer, and forming a gate electrode over the hafnium oxide and lanthanum-containing dielectric layers. As may be appreciated from the discussion above regarding the deficiencies of Ota as applied to claims 1 and 20, Ota does not disclose or suggest forming a layer consisting of hafnium on and in contact with a silicon-containing surface of a semiconductor substrate. Paragraph [0076] merely describes that $HfSiO_2$ film 21 "may be formed by evaporating HfSi in a vacuum and oxidizing it with O_2." Notably the evaporated HfSi does not form a layer consisting of hafnium, as set forth in claim 55. At least for such reasons, claim 55 is patentable.

Applicant asserts that claims 1, 2, 6-8, 13-15, 18-20, 24, 25, 29-31, 52, 54, and 55 are patentable over Ota. Applicant requests allowance of such claims in the next Office Action.

Claims 3-5, 23, 27, and 58 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Ota in view of Kaushik. Applicants request reconsideration.

Claim 3 is amended herein to incorporate in independent form the subject matter of previous claim 1 from which claim 3 depended. In addition, amended claim 3 now sets forth a heating feature. Accordingly, amended claim 3 sets forth a dielectric forming method that includes, among other features, providing a substrate having a silicon-containing surface, forming a layer of silicon dioxide over the surface, forming a metal layer over the silicon dioxide, heating the metal layer and silicon dioxide to a temperature of from about 200° C to less than 400° C, combining metal of the metal layer with oxygen of the silicon dioxide layer to form a metal oxide dielectric material included in a first metal-containing dielectric layer, and forming a second metal-containing dielectric layer on and in contact with the first metal-containing dielectric layer. All the metal of the first dielectric layer consists of at least one element of Group IVB of the period table. All of the metal of the second dielectric layer consists of at least one element of Group IIIB of the periodic table.

Pages 4-5 of the Office Action allege that Ota discloses every element of claim 3 except for forming the silicon dioxide layer and combining metal of the metal layer with oxygen of the silicon dioxide layer to form a metal oxide dielectric material. The Office Action relies upon Kaushik as allegedly disclosing the subject matter missing from Ota.

However, Applicant asserts that Kaushik does not disclose combining metal of a metal layer with oxygen of a silicon dioxide layer to form a metal oxide. Also, Applicant asserts that Kaushik does not disclose heating the metal layer and silicon dioxide to a temperature of from about 200° C to less than 400° C.

Column 3, lines 13-24 of Kaushik clearly describe that the combining of silicon dioxide and metal of Kaushik involves diffusing a metal layer into a silicon dioxide layer at a temperature of from about 400° C up to about 1000° C. The result of diffusing metal into silicon dioxide is to form a silicate material as described in column 3, lines 36-40. In contrast, the method of claim 3 sets forth combining metal of the metal layer with oxygen of the silicon dioxide layer to form a metal oxide. A metal oxide is distinguishable from a silicate material.

In addition, amended claim 3 sets forth heating the metal layer and silicon dioxide to a temperature of from about 200° C to less than 400° C. The diffusion step of Kaushik thus occurs at a higher temperature compared to the heating in claim 3. Paragraph [0034] along with paragraphs [0025] and [0033] of the present specification describe that heating a metal layer and silicon dioxide to a temperature of from about 200° C to less than 400° C results in formation of a metal oxide. The heating in claim 3 may thus be contrasted with the diffusion step of Kaushik which instead results in formation of a silicate material.

Kaushik thus fails to disclose forming a metal oxide dielectric material since it only describes forming a silicate material by a diffusion step. Kaushik also fails to disclose heating a metal layer and silicon dioxide at a temperature of from about 200° C

to less than 400° C. Based on the express teachings of Kaushik, those of ordinary skill would find that failing to provide the higher temperatures described by Kaushik would prevent proper formation of the desired silicate material. Further, failure to provide the higher temperature diffusion step of Kaushik and form a silicate material would frustrate an intended purpose of Kaushik. Thus, no motivation can be deemed to exist to modify the express teachings of Kaushik and instead heat at a lower temperature to form a metal oxide dielectric material.

A finding of obviousness requires disclosure or suggestion of every claim limitation. As may be appreciated from the assertions herein, both Ota and Kaushik fail to disclose or suggest heating a metal layer and silicon dioxide to a temperature to combine metal of the metal layer with oxygen of the silicon dioxide and to form a metal oxide dielectric material. At least for such reason, amended claim 3 is patentable. Claims 4 and 5 depend from claim 3 and patentable at least for such reason as well as for the additional limitations of such claims not disclosed or suggested.

Claims 23 and 27 depend from claim 20 the subject matter of which is discussed above. Kaushik does not disclose or suggest and is not alleged to disclose or suggest the deficiencies of Ota as applied to claim 20 and discussed herein. Combination of Ota and Kaushik cannot be considered to disclose or suggest subject matter that is absent from both. At least for such reason, claims 23 and 27 are patentable.

Claim 58 sets forth a dielectric layer forming method that includes, among other features, providing a substrate with a silicon-containing surface, forming a layer of silicon dioxide, forming a hafnium-containing layer over the silicon dioxide, combining

hafnium of the hafnium-containing layer with oxygen of the silicon dioxide to form a hafnium oxide, forming a lanthanum-containing layer over the hafnium-containing layer, and positioning the substrate within a reaction chamber and exposing the hafnium-containing layer and the lanthanum-containing layer to oxygen radicals within the reaction chamber. The method includes heating the hafnium-containing layer and the lanthanum-containing layer to a temperature effective to form a hafnium-containing dielectric layer and a lanthanum-containing dielectric layer.

Page 6 of the Office Action alleges that Ota in view of Kaushik discloses every limitation of claim 58. However, as may be appreciated from the discussion above regarding the deficiencies of the art combination as applied to claim 3, Ota in view of Kaushik does not disclose or suggest combining hafnium with oxygen to form a hafnium oxide. Kaushik merely describes forming silicate materials. Also, page 7 of the Office Action states that claim 12 is allowed since the prior art of record fails to disclose or suggest exposure to oxygen radicals. Claim 58 sets forth exposing the hafnium-containing layer and the lanthanum-containing layer to oxygen radicals. At least for the indicated reasons, claim 58 is patentable over the cited combination. Applicant requests allowance of claims 3-5, 23, 27, and 58 in the next Office Action.

Claims 9, 16, 17, 21, and 22, stand rejected under 35 U.S.C. §103(a) as being unpatentable over Ota in view of Zhang. Applicant requests reconsideration.

Claims 9, 16, and 17 depend from claim 1 while claims 21 and 22 depend from claim 20. The subject matter of claims 1 and 20 is discussed above. Zang does not disclose or suggest and is not alleged to disclose or suggest the deficiencies of Ota as

applied to claims 1 and 20. Accordingly, combination of Ota and Zang cannot be considered to somehow disclose or suggest subject matter that is absent from both. At least for such reason, claims 9, 16, 17, 21 and 22 are patentable over the cited combination. Applicant requests allowance of such claims in the next Office Action.

Claims 1-31, 52, and 54-59 are established herein as in condition for allowance. Applicant requests allowance of all such pending claims in the next Office Action.

Respectfully submitted,

Date 26 Sep 2003 Signed _____

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